$T \rightarrow tZ(\nu\nu)$ Update

CMS Meeting

11/05/2018

C. Giugliano[1], A.O.M. Iorio[1],

Giulia Giannini[2], Annapaola de Cosa[2], Florencia Canelli[2]

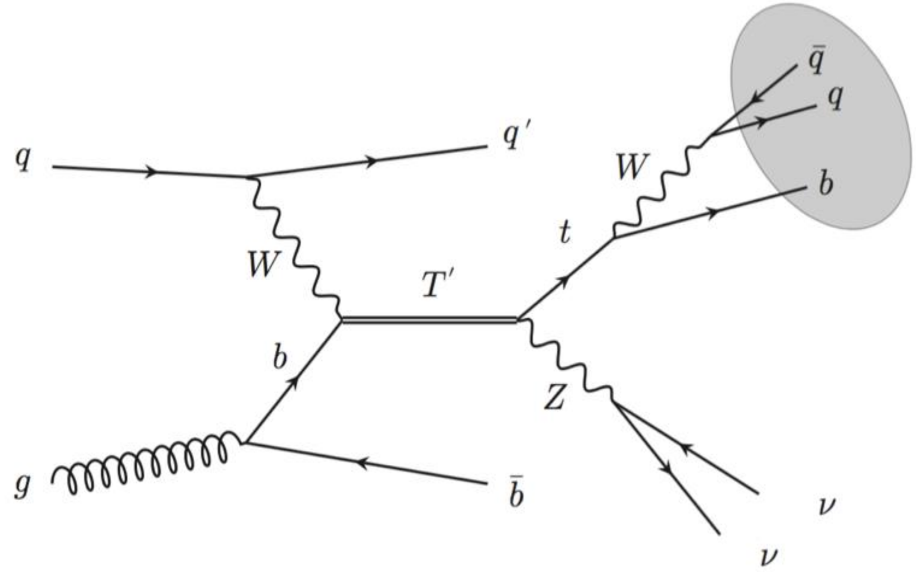
[1]INFN Sezione di Napoli and University of Naples

[2]UZH University of Zurich

Outline:

- New samples addition and checks
- Trigger improvements and scale factor measurement
- Background estimation
- Study of systematic uncertainties
- Results fitting different observables (MT or MET)

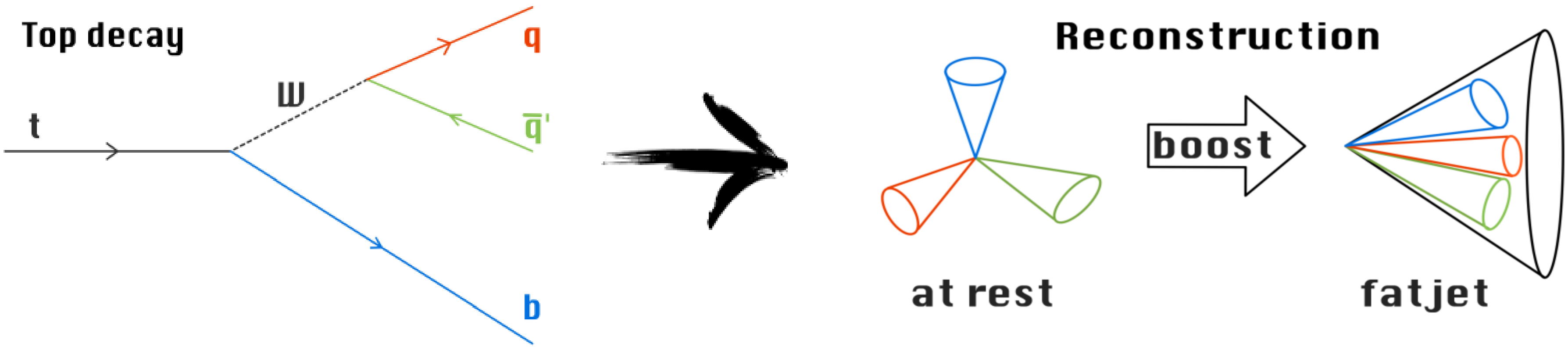
Signal topology:



Final state:

- Hadronic top decay
- Z in **νν** (MET)

The decay products of the boosted top cannot be individually reconstructed:



Samples:

Full 2016 Dataset
REMINIAOD+ Moriond MC Samples

Data	/MET/Run2016B-23Sep2016-v3*/MINIAOD /MET/Run2016C-23Sep2016-v1*/MINIAOD /MET/Run2016D-23Sep2016-v1*/MINIAOD /MET/Run2016E-23Sep2016-v1*/MINIAOD /MET/Run2016F-23Sep2016-v1*/MINIAOD /MET/Run2016G-23Sep2016-v1*/MINIAOD /MET/Run2016H-PromptReco-v2*/MINIAOD /MET/Run2016H-PromptReco-v3*/MINIAOD
T	/TprimeBToTZ_M-*RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM
TT	/TT*to*_TuneCUETP8M2T4_13TeV-powheg-pythia8/*Moriond17*/MINIAODSIM
QCD	/QCD_HT*to*_TuneCUETP8M1_13TeV-madgraphMLM-pythia8/*Moriond17*/MINIAODSIM
Z+Jets	/ZJetsToNuNu_HT*To*madgraph/*Moriond17*/MINIAODSIM
W+Jets	/WJetsToLNu_HT*To*_TuneCUETP8M1_13TeV-madgraphMLM-pythia8/*Moriond[illegible]AODSIM
SingleTop	/ST_s-channel_*13TeV-amcatnlo-pythia8_TuneCUETP8M1/*Moriond17*/MNIAODSIM /ST_t-channel_*13TeV-powhegV2-madspin-pythia8_TuneCUETP8M1/*Moriond17*/MINIAODSIM /ST_tW_*13TeV-powheg-pythia8_TuneCUETP8M2T4/*Moriond17*/MINIAODSIM
Dibosons	/WW_TuneCUETP8M1_13TeV-pythia8/*Moriond17*/MINIAODSIM /WZ_TuneCUETP8M1_13TeV-pythia8/*Moriond17*/MINIAODSIM /ZZ_TuneCUETP8M1_13TeV-pythia8/*Moriond17*/MINIAODSIM

Samples:

TT	/TT*to*_TuneCUETP8M2T4_13TeV-powheg-pythia8/*Moriond17*/MINIAODSIM /TT_Mtt-700to1000_TuneCUETP8M2T4_13TeV-powheg-pythia8/*Moriond17*/MINIAODSIM /TT_Mtt-1000toInf_TuneCUETP8M2T4_13TeV-powheg-pythia8/*Moriond17*/MINIAODSIM
QCD	/QCD_HT*to*_TuneCUETP8M1_13TeV-madgraphMLM-pythia8/*Moriond17*/MINIAODSIM
Z+Jets	/ZJetsToNuNu_HT*To*madgraph/*Moriond17*/MINIAODSIM
W+Jets	/WJetsToLNu_HT*To*_TuneCUETP8M1_13TeV-madgraphMLM-pythia8/*Moriond17*/MINIAODSIM
SingleTop	/ST_s-channel_*13TeV-amcatnlo-pythia8_TuneCUETP8M1/*Moriond17*/MNIAODSIM /ST_t-channel_*13TeV-powhegV2-madspin-pythia8_TuneCUETP8M1/*Moriond17*/MINIAODSIM /ST_tW_*13TeV-powheg-pythia8_TuneCUETP8M2T4/*Moriond17*/MINIAODSIM
Dibosons	/WW_TuneCUETP8M1_13TeV-pythia8/*Moriond17*/MINIAODSIM /WZ_TuneCUETP8M1_13TeV-pythia8/*Moriond17*/MINIAODSIM /ZZ_TuneCUETP8M1_13TeV-pythia8/*Moriond17*/MINIAODSIM

Check on signal cross section:

Update of the cross section of the signal samples with the ones that other single T analysis plan to use! New cross section are smaller by a factor 10

Sample		NLO Cross-SectionXBR (T->top +Z)(fb)	NLO Cross-SectionXBR (T-> top + Z)(fb)
T	/TprimeBToTZ_M-700RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	1455	88.6
	TprimeBToTZ_M-800RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	965	45.9
	TprimeBToTZ_M-900RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	680	25.1
	TprimeBToTZ_M-1000RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	487	14.5
	TprimeBToTZ_M-1100RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	337.5	8.67
	TprimeBToTZ_M-1200RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	245.5	5.36
	TprimeBToTZ_M-1300RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	179	3.39

NEW

Check on signal cross section:

Update of the cross section of the signal samples with the ones that other single T analysis plan to use! New cross section are smaller by a factor 10

Sample		NLO Cross-SectionXBR (T->top +Z)(fb)	NLO Cross-SectionXBR (T-> top + Z)(fb)
T	/TprimeBToTZ_M-1400RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	135	2.19
	TprimeBToTZ_M-1500RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	102	1.45
	TprimeBToTZ_M-1600RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	76.25	0.97
	TprimeBToTZ_M-1700RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	57.5	0.66
	TprimeBToTZ_M-1800RH_TuneCUETP8M1_13TeV-madgraph-pythia8/*Moriond17*/MINIAODSIM	43.5	0.46

New Trigger:

- Trigger MET:
  1) HLT_PFMHTNoMu120_PFMHTNoMu120_IDTight
  2) HLT_PFMHTNoMu110_PFMHTNoMu110_IDTight

1) OR 2)

As suggested in → CMS AN-16-429

- Trigger SingleMuon (HLT_Mu50):
  - Non isolated muon with Pt > 50 GeV at HLT level
  - Used for trigger efficiency measurement

New Trigger:

- Trigger SingleMu:

nLooseElectrons[0]==0 && muonsTight_size	→	to have at least one Tight muon that triggered the single Muon
muonTight_Pt>60 GeV	→	to stay on the plateau of the turn-on curve

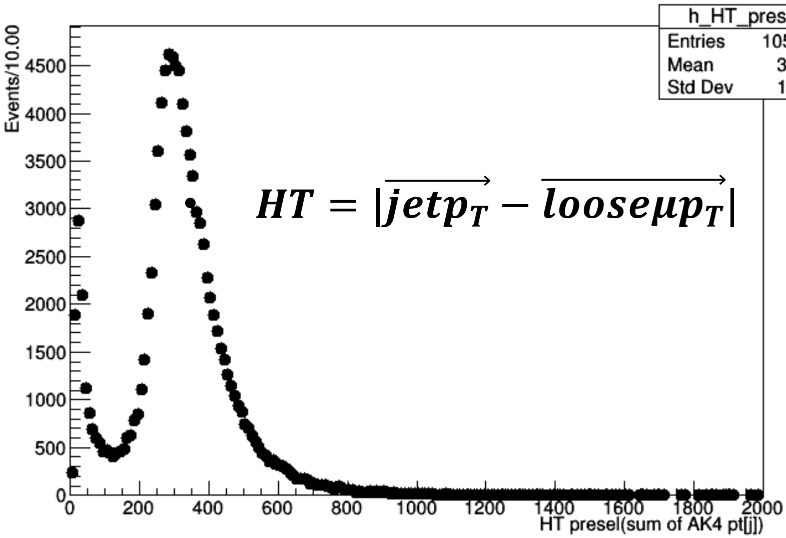
Introduction of two variables:

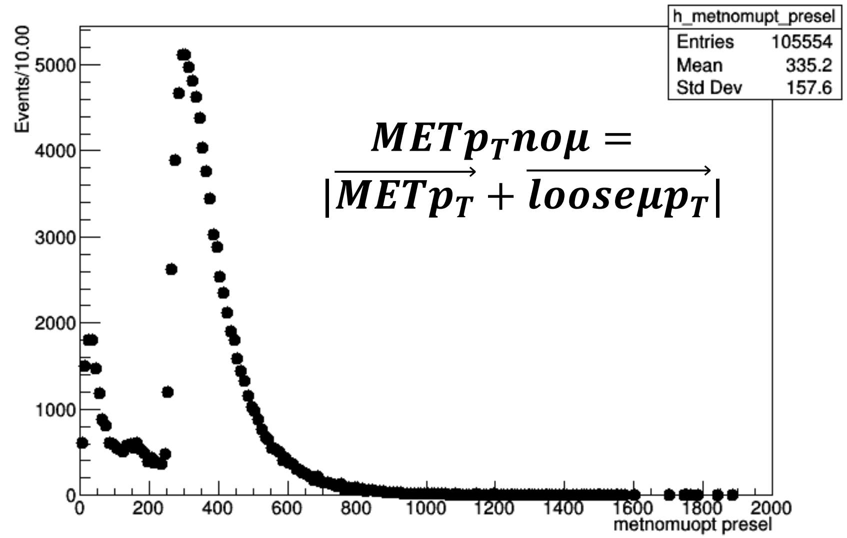
$$HT = |\overrightarrow{jetp_T} - \overrightarrow{loose\mu p_T}|$$

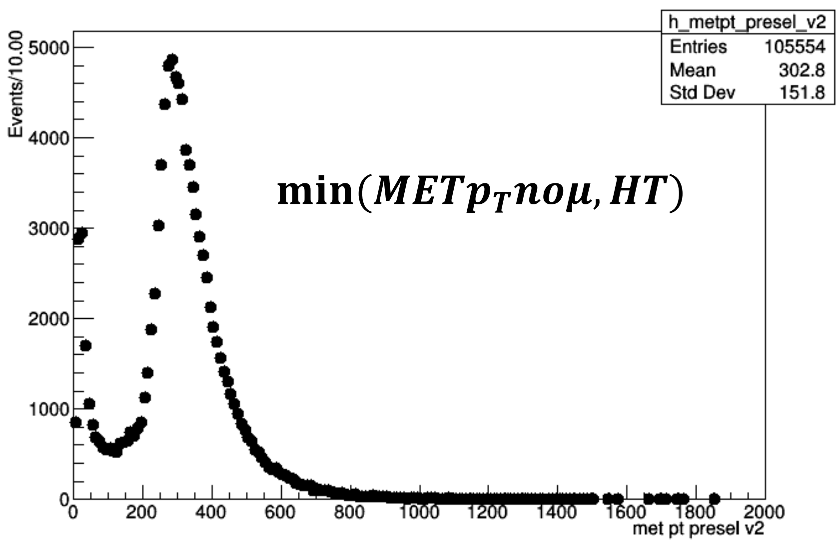
$$METp_T no\mu = |\overrightarrow{METp_T} + \overrightarrow{loose\mu p_T}|$$

$$\min(METp_T no\mu, HT)$$

New Trigger:

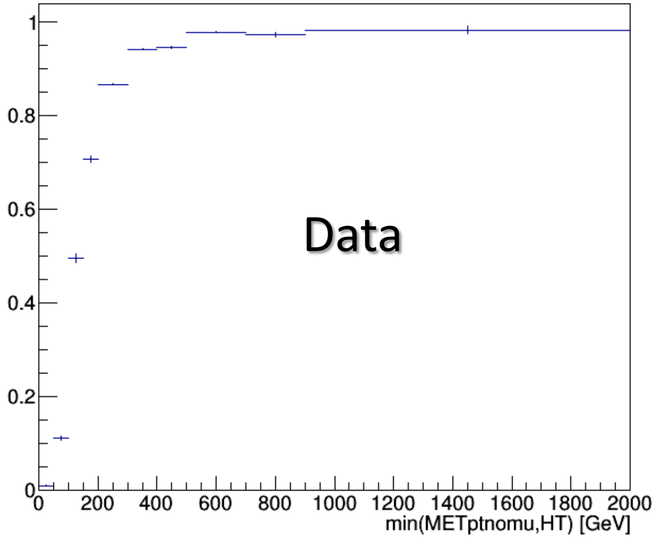

h_HT_presel
Entries 105554
Mean 314.2
Std Dev 154.5
Events/10.00
HT presel(sum of AK4 pt[j])
$HT = |\overrightarrow{jetp_T} - \overrightarrow{loose\mu p_T}|$

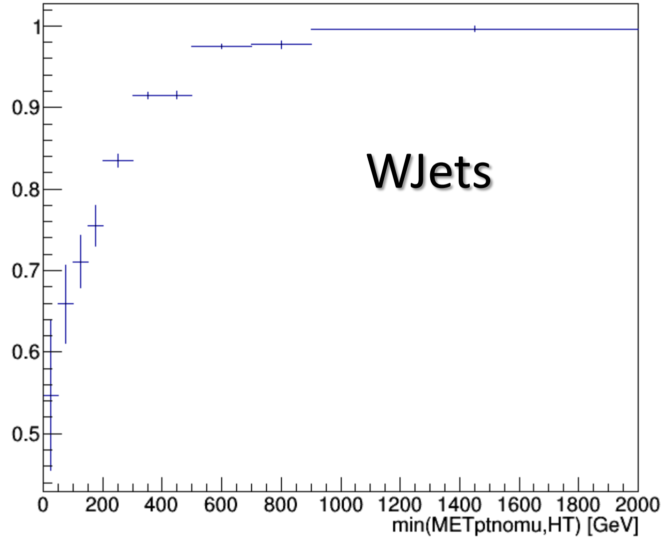

h_metnomupt_presel
Entries 105554
Mean 335.2
Std Dev 157.6
Events/10.00
metnomuopt presel
$METp_T no\mu = |\overrightarrow{METp_T} + \overrightarrow{loose\mu p_T}|$

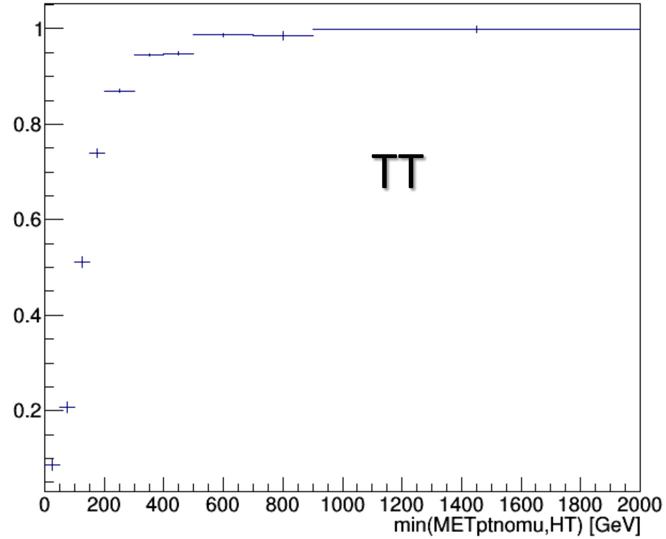

h_metpt_presel_v2
Entries 105554
Mean 302.8
Std Dev 151.8
Events/10.00
met pt presel v2
$\min(METp_T no\mu, HT)$

Data and MC efficiency vs min(METp$_T$noμ, HT):

$$efficiency = \frac{triggerMET\ \&\&\ triggerSingle\mu}{triggerSingle\mu}$$



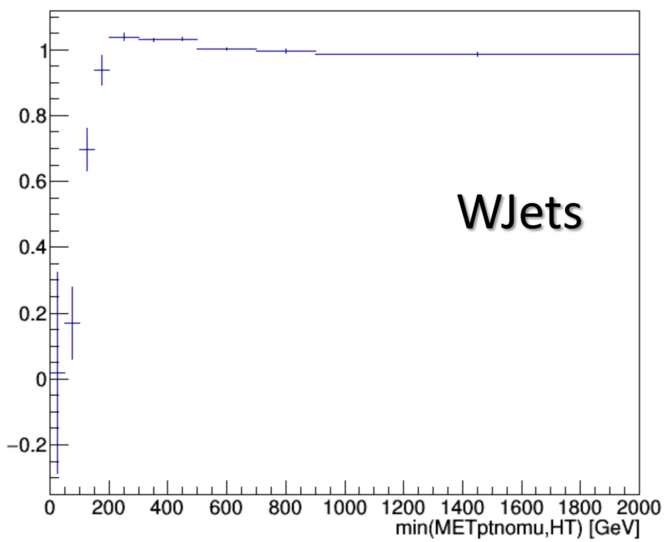


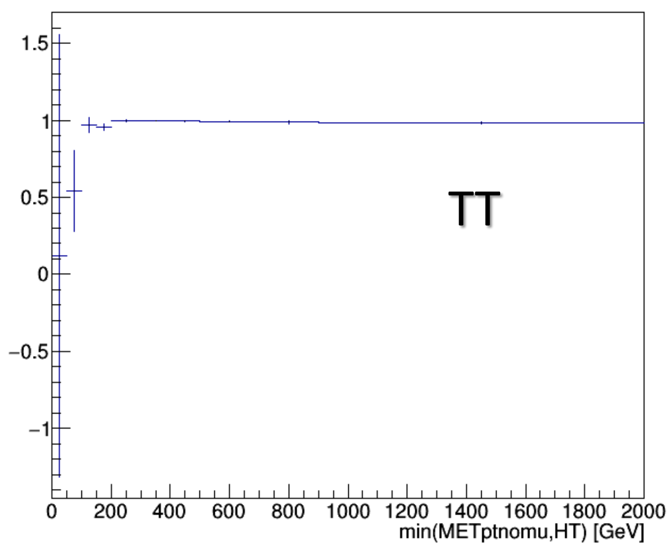


VARIABLE BINNING

Scale Factor:

$$Scale\ Factor = \frac{Data\ efficiency\ over\ \min(METp_T no\mu, HT)}{MC\ efficiency\ over\ \min(METp_T no\mu, HT)}$$



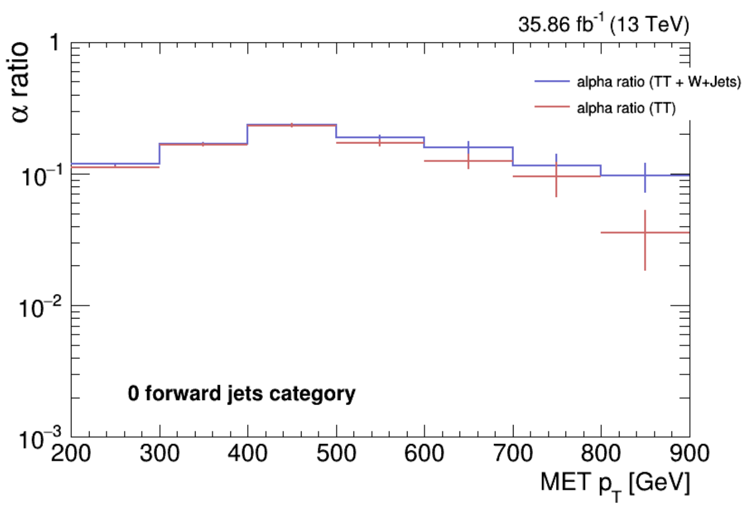


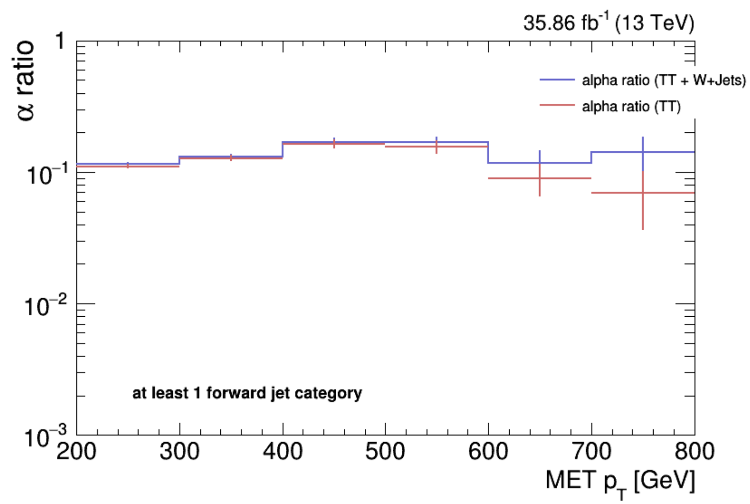
Background estimation:

In order to rely as little as possible on the simulation, the dominant irreducible background is partially estimated from data using the "**alpha ratio method**".

$$N_{SR} = \left[N_{CR}^{Data} - \left(N_{CR}^{QCD} + N_{CR}^{ZJets} + N_{CR}^{ST} + N_{CR}^{VV}\right)\right] \cdot \frac{\left(N_{SR}^{TT} + N_{SR}^{WJets}\right)}{\left(N_{CR}^{TT} + N_{CR}^{WJets}\right)}$$

alphaRatio

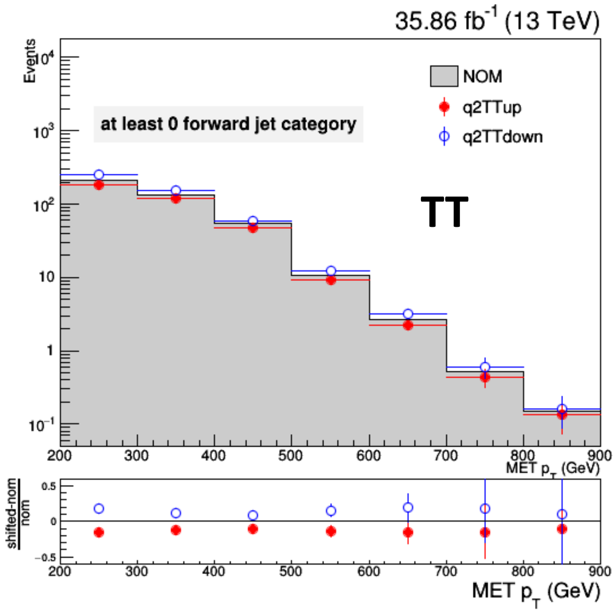


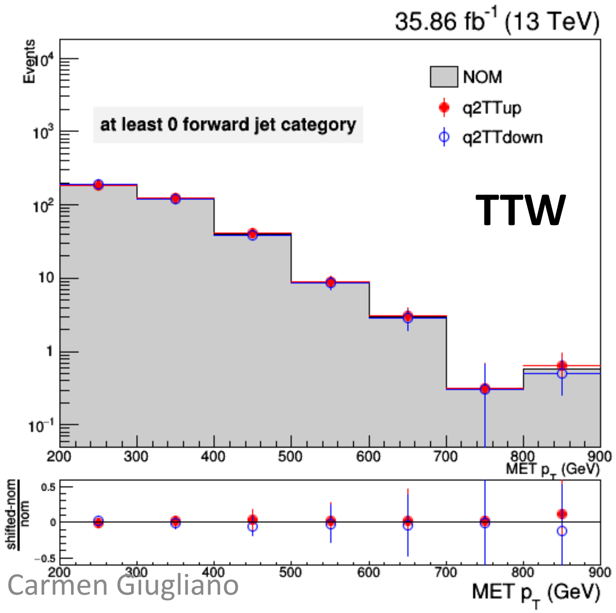


The shape of the distribution is obtained from the data in the CR and corrected by alpha, which is bin dependent.

Systematics:

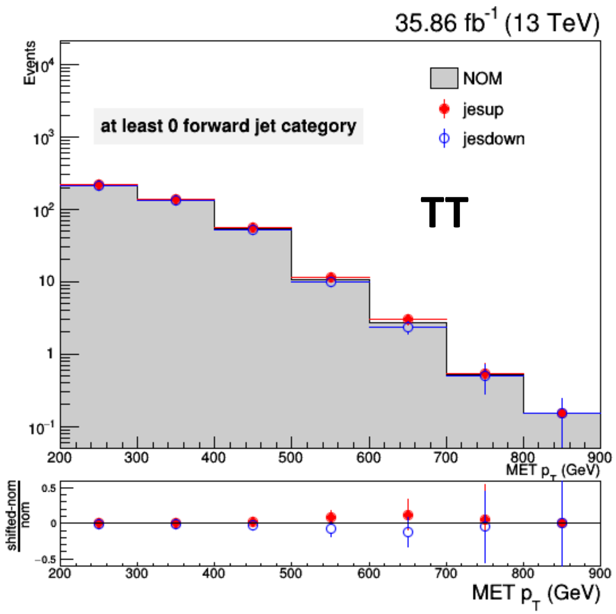
- *btag;*
- *mistag;*
- *pu;*
- *pdf;*
- *topTag;*
- *WTag;*
- *jes;*
- *jer;*
- *q2:*
  - *q2WJets;*
  - *q2ZJets;*
  - *q2TT;*
  - *q2QCD;*
  - *q2Tprime*

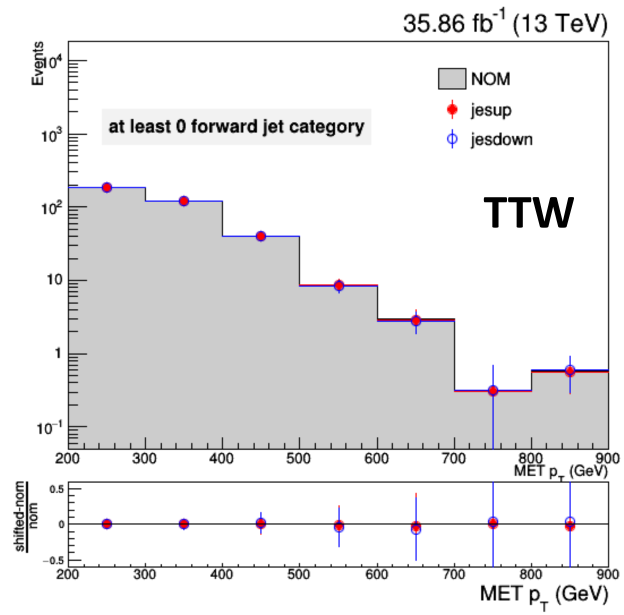




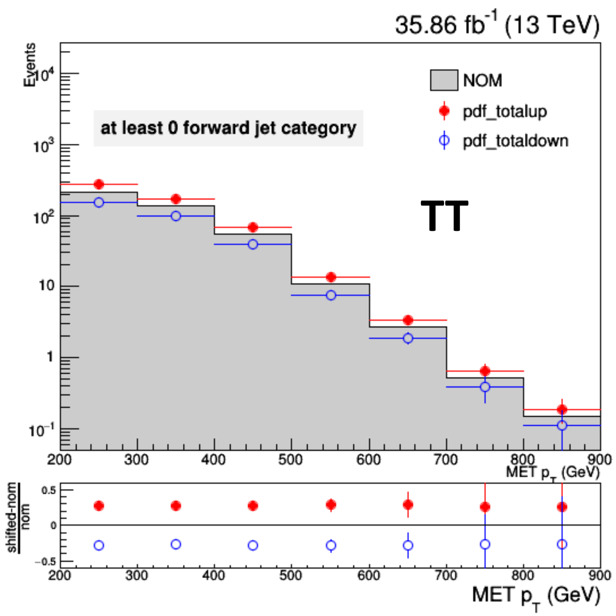
q2TT

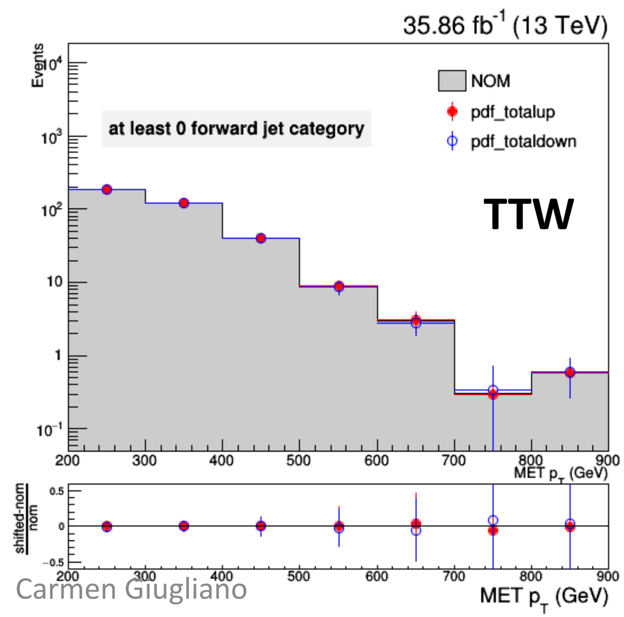
Systematics:





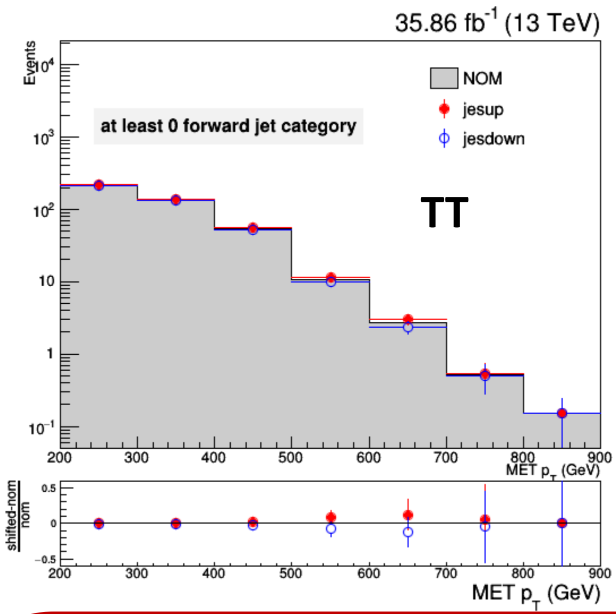
jes

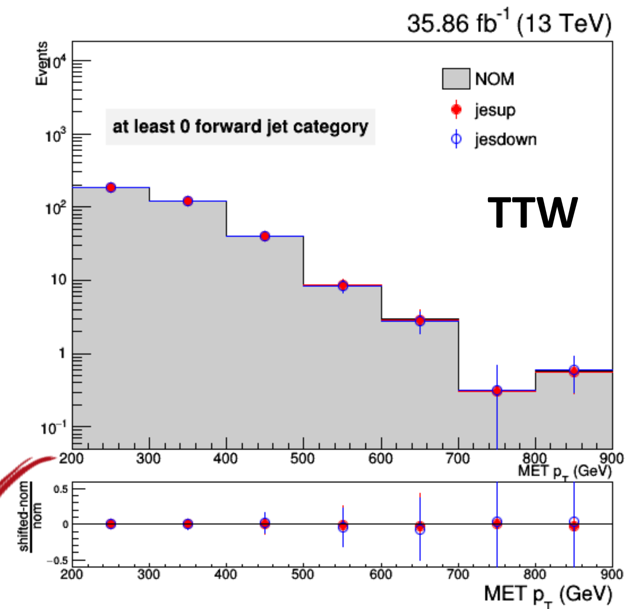




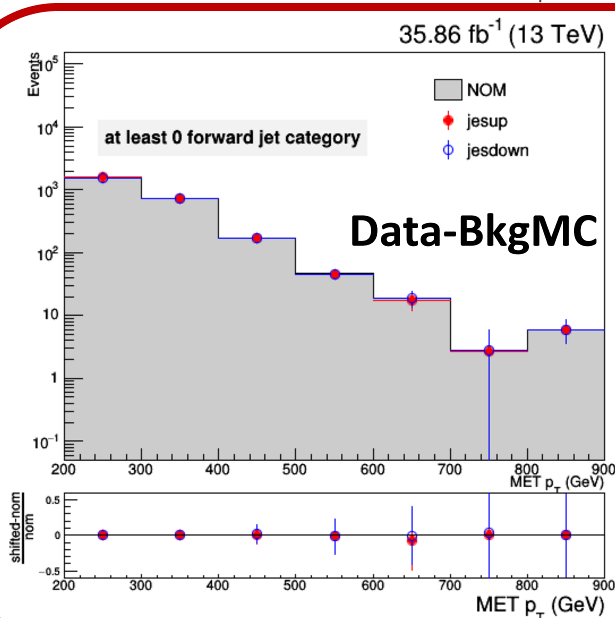
pdf

Systematics:

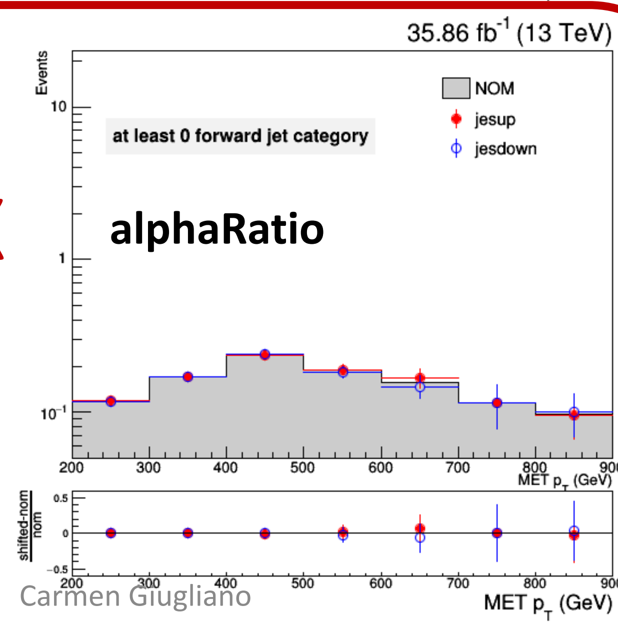




jes



X



Calculation of expected limit:

We calculated the expected limit in two different fit for each variable (MET, MT):

$$M_T = \sqrt{2\, topP_T \cdot METP_T (1 - \cos\Delta\varphi)}$$

TTW_DD fit

- TT and W+jets estimated from data as described.
- The other backgrounds are instead taken from simulation.

TTW_MC fit

- All backgrounds are taken from simulation.

- # Fit results:

$$r = \frac{\sigma_{mes}}{\sigma_{pre}}$$

Expected @95% CL

$$\rightarrow r = \frac{\sigma_{mes}}{\sigma_{pre}} \cdot \sigma_{pre}$$

	RH800 σ*BR(fb)	RH1200 σ*BR(fb)	RH1400 σ*BR(fb)	RH1600 σ*BR(fb)	RH1800 σ*BR(fb)
MET_MC	771.70	104.18	69.26	49.23	40.13
MET_DD	651.21	124.95	76.92	49.71	39.67
MT_MC	674.16	96.81	62.69	43.47	34.90
MT_DD	622.52	110.21	70.35	45.95	37.17

The limit improves with increasing T' masses because the shape has better discrimination power but then get worse because the cross section is lower at higher masses.

- M800 actually has lower acceptance as well because of kinematic cuts, hence the worse limit with respect to 1200

Near future plan:

- Add the trigger scale factor
- Add mcstats
- Remake limits and make limit plots
- Add 2017 data(eventually)